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ABSTRACT

An experiment was carried out on perceived difficulty of a simple attention task. Seven complex stimulus matrices were used, consisting of different numbers of pairs of consonants. The subjects' task was to search for targets determined by the experimenter one by one. Search time was measured as performance criterion. Perceived difficulty of the task was measured by the method of magnitude estimation, one of the matrices serving as standard. The results showed perceived difficulty to be a negatively accelerated function of both stimulus and response variables involved. It appears probable that the estimates of difficulty were contaminated by the structure and size of the visual field, particularly by the estimation of numerousness. It is concluded that isolation of the perception and, hence, of the estimation of difficulty is an important methodological problem in the area under study. (Author)

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PERCEIVED DIFFICULTY OF A VISUAL SEARCH TASK

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PERCEIVED DIFFICULTY OF A VISUAL SEARCH TASK*

Borg, G., Bratfisch, O., and Dornič, S. Perceived difficulty of a visual search task. Reports from the Institute of Applied Psychology, The University of Stockholm, 1971, No. 16. - An experiment was carried out on perceived difficulty of a simple attention task. Seven complex stimulus matrices were used, consisting of different number of pairs of consonants. The Ss' task was to search for targets determined by the experimenter one by one. Search time was measured as performance criterion. Perceived difficulty of the task was measured by the method of magnitude estimation, one of the matrices serving as standard. The results showed perceived difficulty to be a negatively accelerated function of both stimulus and response variables involved. It appears probable that the estimates of difficulty were contaminated by the structure and size of the visual field, particularly by the estimation of numerousness. It is concluded that isolation of the perception and, hence, of the estimation of difficulty is an important methodological problem in the area under study.

Introduction and problem

Visual search tasks represent a modern type of attention experiment. Visual search activity has been defined as a continuous, repetitive process of solving a discrimination problem, performed, as a rule, with emphasis on speed (cf. Forsman, 1967). In a typical search task S scans a complex visual display in order to identify and locate one or more critical stimuli called targets.

Visual search tests have many advantages such as reliability, sensitivity to a wide range of stimulus parameters, universal usability for all age categories etc. (cf. Neisser, 1963; Eriksen, 1953; Smith, 1962; Gibson & Yonas, 1966). For a general survey see, e.g., Neisser, 1967. Laboratory forms of search behavior represent models of many professional as well as current everyday activities. They make it possible to study the relationships between the sensory and perceptual stages of cognitive processes as well as the basic memory mechanisms conditioning man's orientation in life situations (cf. Cizková, 1967; Chalupa & Dornič, 1969; Kaplan, Carvellas & Metlay, 1966; Wright, 1970 etc).

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As can be seen from the above literature, attention has been paid so far only to the parameters and indices of "objective" difficulty of search tasks. However, during the last few years it has become clear that a modern approach should include another aspect, viz. that of perceived or subjective difficulty. Since about a decade ago, the possibility has been repeatedly demonstrated of studying this problem in different areas (Borg & Dahlström, 1960; Borg, 1961; 1962; Borg & Forsling, 1964; Bratfisch & Ekman, 1969). A general survey of theoretical and methodological questions involved was given recently (Borg, Bratfisch, Dornič, 1970) and a wider research project was then designed to perform pilot studies of perceived difficulty of motor, perceptual, memory, attention and problem solving tasks. Two experimental studies have already been carried out, viz. in the area of motor skills (Bratfisch, Dornič & Borg, 1970) and immediate memory (Borg, Bratfisch & Dornič, 1971). Both experiments brought rather promising results and pointed out several methodological questions to be solved.

The aim of the present experiment was to study perceived difficulty of a simple visual search task with special regard to possible factors influencing the experience of difficulty.

Method

Seven complex stimulus matrices were used. Each matrix was divided by vertical and horizontal lines into 8 by 8 mm square cells in which pairs of consonants were typed. One of the matrices is shown in Fig. 1. The number of cells, i.e., the number of consonant pairs in the individual matrices was as follows: 5 by 5, 6 by 6, 7 by 7, 8 by 8, 9 by 9, 10 by 10, and 11 by 11. The consonants combinations were constructed in such a way so as to minimize the possible effect of acoustic confusability which may lead, even with visual presentation, to a more difficult short-term retention during searching (Conrad, 1964; Corcoran, 1966). None of the pairs of consonants occurred twice on the same display.

The experimental procedure consisted of two parts. First, the Ss' task was to search for targets determined by the experimenter one by one. Search time was measured as performance criterion. The positions of targets were chosen in such a way so as to neutralize the dependence of search time on the Ss' searching strategies. The matrices were placed at a reading distance from the S's eyes.

In order to obtain perceived difficulty estimates, the psychophysical method of magnitude estimation was then employed. Having completed a given search task, the Ss were asked to estimate its perceived difficulty in relation to standard. The 8-by-8 matrix served as standard denoted 10, and was presented always

CR	VF	RD	FG	VK	CM	FH	RC	SV	MC
RG	MG	BH	KB	GD	DL	HR	GM	HB	FK
VL	KT	HV	HC	SF	RB	CH	HG	TS	KH
KC	SK	BK	FT	CF	LS	VR	KS	MV	FB
VH	KD	MB	KR	HF	SL	MT	BS	HT	CK
FL	BR	FS	LT	MR	LB	DH	LV	SG	DF
LC	HD	GS	GK	TF	MD	CL	BM	KF	LK
TK	DR	TH	RV	DK	SH	FD	MK	HL	SB
TM	GH	SC	FV	LD	RH	GL	KG	VM	DV
CS	RM	TL	BT	DS	HM	BC	TR	KL	GF

Fig. 1. A stimulus matrix used in the present experiment.

before the comparison matrix. If the searching for targets on a comparison matrix was felt to be half as difficult as that on the standard matrix, the S should report "5"; if it was felt twice as difficult, the S should report "20", etc. It was impressed on the Ss that they were to base their estimates on the overall experience of difficulty only, disregarding any possible secondary cues such as time, size of the stimulus field etc.

Each S was thus presented with six pairs of matrices. The order of comparison matrices was randomized and different for each S. To begin with, the Ss were to look for 7 targets on the standard matrix, then for 7 targets on the comparison matrix, and then to give the necessary estimate. Standard was then presented again, followed by another matrix to be compared and so on. The number of targets to be looked for was on all comparison matrices the same (7). However, the number of targets on the standard matrix was reduced to 3, starting with the second pair. This was done in order to minimize the probability that the Ss would remember the positions of stimuli, though such a probability was shown to be extremely low (Neisser, 1967; Wright, 1970). Besides, two different versions of the standard matrix were used.

Twenty subjects (8 males an 12 females), ranging in age from 20 to 31 years, took part in the experiment. A few of them had some previous experience with direct scaling methods.

Results

Medians were computed first from the individual values of search time for each S and arithmetic means were then calculated for the group. They are shown in Table 1 (upper row) together with medians of the estimates of perceived difficulty (lower row). As could be expected, search time was a positively accelerated function of the task complexity (number of pairs of consonants). With the increase from 25 to 121 stimuli (somewhat less than five times), search time increased almost eight times.

Table 1. Search time and perceived difficulty.

Matrices	5 x 5	6 x 6	7 x 7	8 x 8	9 x 9	10 x 10	11 x 11
Search time in secs	2.2	4.1	7.2	9.6	11.2	14.1	17.3
Perceived difficulty	3.5	6.5	8.7	(10.0)	12.5	14.5	15.1

Perceived difficulty was plotted against the other variables - first of all, against the only performance measure - search time, and then against stimulus variables which might have influenced the Ss' experience of difficulty (visual field complexity, i.e. number of stimuli, as well as the length of the sides of the visual field). In all those cases, perceived difficulty was found to be a more or less negatively accelerated function of the individual variables. Fig. 2 shows the relationship between perceived difficulty and the number of stimuli in the visual field; here a straight line could be obtained when using log values on the horizontal axis.

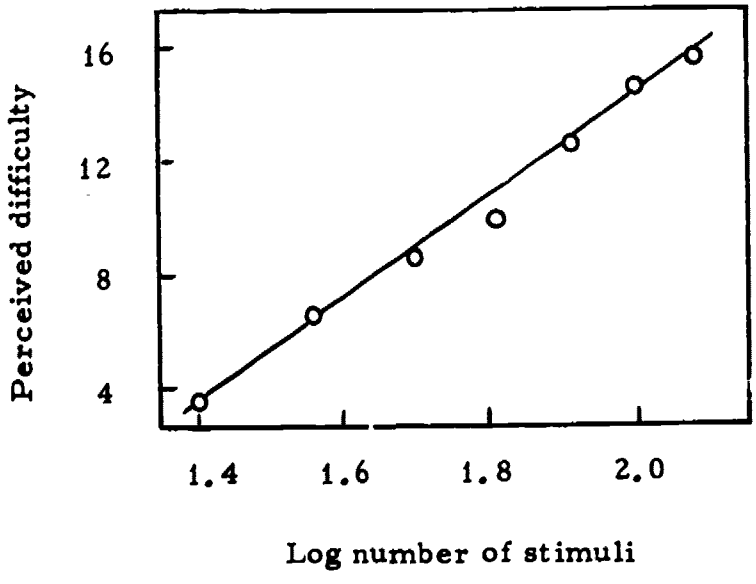

Fig. 2. Perceived difficulty as a function of log stimulus number.

Since a part of the sample (13 Ss) was tested also by means of a non-verbal intelligence test (an abbreviated version of the Raven Progressive Matrices), possible relationship was looked for between the Ss' scores in the test and their estimation of difficulty. Six Ss with the highest scores (mean = 21.8 out of 24 possible points) were compared with six Ss with the lowest score (mean=15.5). The comparison is presented in Table 2 (subgroup A = 6 best Ss, subgroup B = 6 worst Ss).

Table 2. Search time and perceived difficulty (subgroups A and B).

Matrices		5 x 5	6 x 6	7 x 7	8 x 8	9 x 9	10 x 10	11 x 11
Search time in secs	A	2.3	4.6	7.1	10.3	11.0	15.0	16.9
	B	2.6	4.1	7.1	8.9	11.9	12.8	18.1
Perceived difficulty	A	3.5	6.5	8.2	(10.0)	13.5	15.0	19.5
	B	4.5	6.2	8.0	(10.0)	11.3	12.5	15.3

As can be seen from the table, there was no systematic difference between the subgroups in search time, but subgroup A estimated the most complicated tasks as more difficult than subgroup B.

Discussion

Although the possibility cannot be ruled out that the Ss succeeded in giving "genuine" estimates of difficulty, it seems rather probable that the estimates were contaminated by some secondary factors.

The criterion of the "objective" difficulty of the search task employed was time, which was shown to be a positively accelerated function of the task complexity (number of stimuli). Had the time perception served as basis for the estimates of difficulty (as was the case with a motor-skill task - cf. Bratfisch, Dornić, & Borg, 1970), the relation between perceived difficulty and task complexity should follow a similar trend, since subjective time is, up to about half a minute, practically a linear function of objective time (Frankenhaeuser, 1959).

Probably the closest relation could be expected between perceived difficulty and the s u b j e c t i v e complexity of the visual fields, i.e., the subjective number of elements in it.

Underestimation of numerousness of simultaneously exposed visual stimuli is now a well-established fact, first described by Hamilton more than a century ago and widely verified in Taves' extensive investigations (for survey, see Woodworth & Schlosberg, 1961). This underestimation grows along with the number of elements in the stimulus field, and it is especially pronounced with continuous visual fields (Dornič, 1965; 1970) similar to those used in the present experiment.

The estimates of difficulty in the present investigation could also be affected by the estimation of area; subjective area was also shown to grow more slowly than its objective counterpart (Ekman, Bergström & Künnapas, 1956).

The problem of contamination of psychophysical estimates by secondary factors is a general one and concerns all kinds of psychophysical experiments. Ss must be reminded almost always not to use certain cues which might affect the "genuineness" of their estimates. In a typical experiment on visual perception, Ss estimate the stimuli which are present in their visual field and there is no need to "abstract" from them. In the present experiment, however, S was supposed to disregard the primary perceptual qualities of the stimuli he was looking at, and to judge something else. To what degree a S is able to cope with such a task, might depend on several factors.

Though the difference between the two subgroups in the present experiment cannot be generalized, it seems possible that higher estimates of perceived difficulty in subgroup A might be due to the Ss' better ability to "abstract" from irrelevant aspects of the stimuli and thus to follow the instruction more properly. A better capability of these Ss to handle numbers must also be taken into account, as pointed out by Borg & Forsling (1965, 1966) and by Borg (1967).

In the last three studies (perceived difficulty of motor, memory and attention tasks) different functions were found. It is an open question whether the differences found reflect some specific characteristics of the tasks or they are due to different degree of contamination by secondary factors. In any case, it seems obvious that the experience of difficulty is influenced both by stimulus and response variables. A major methodological question to be solved is, how to isolate the perception and, hence, the estimation of difficulty.

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